INTRAOCULAR LENS

This invention concerns an improvement in intraocular lenses for implant into the human eye and particularly a lens to be implanted in the posterior chamber of the eye and within the posterior capsule of the natural lens after the nucleus of the lens has been removed.

Modern opthalmic surgical techniques have developed a number of devices and modalities for providing substitutions for the natural eye lens. Although significant advances have been made, current devices and techniques leave much to be desired.

Typical intraocular lenses in use today utilize an optical element which is supported by a pair of haptics to position the lens within the eye. The materials chosen for use are those which have been found to be tolerated by the patient and which do not deteriorate in that environment. Typically, the optical elements themselves are formed of PMMA (polymethyl methacrylate), and the haptic portions or support elements are formed of PMMA or metal elements which are not harmful to the eye. The implantation of these devices in the extremely small and extremely delicate environment of the eye has been beset with difficulties and problems, and the use of haptic members has produced a series of problems. Since it is required to insert the lens through the iris of the eye, it was believed that haptic support elements must extend in opposite directions from the lens such that it may be inserted axially through the iris and then rotated to allow the haptics to position the lens on two opposing sides. It has been found that too often lenses of that type thus installed migrate, and/or the haptic devices produce an adverse pathology at the small points where they contact the inner elements of the eye. Lenses with such support devices are shown, for example, in U.S. Pat. Nos. Re. 31640 and 4,588,406. Other types of implants have been suggested, such as in U.S. Pat. No. 4,254,509, for an interior lens to be placed in front of the iris, and in U.S. Pat. No. 4,172,297 which shows a lens intended to be held in position by attachment to the iris of the eye. U.S. Pat. No. 3,711,870 shows a lens designed to be sutured to the ciliary muscle of the eye, which lens has not been successful, presumably because it is too big to be practically inserted within the eye and because suturing to the ciliary muscle appears to be impractical. Reference to these patents and to the references cited therein provide much information as to the investigations and proposals which have been made in this area.

A need exists for an intraocular lens which has support means allowing the lens to be held within the natural lens capsule (after the nucleus has been removed) in a manner in which the lens is maintained on axis in the eye and where those support materials do not irritate or otherwise damage the eye. The inventor conceived that such support would be best provided by a soft and generally circular rim of support means which extends radially away from the optical portion of the lens, in all directions, to provide peripheral support completely around the entire periphery of the device where it physically contacts the interior portions of the eye. At the same time, such a lens must be capable of being inserted through the opening of the iris of the eye (which typically cannot be dilated greater than approximately 10 mm) and, alternatively, should be insertable through a slit in the anterior capsule of the natural lens which may be as small as 4.5 to 5 mm or smaller. The foldable lens disclosed and claimed herein meets each of those specifications.

Generally, it is an object of the present invention that there be provided an improved intraocular lens for insertion into a human eye in substitution for the natural lens which improves over such lenses heretofore available.

It is a more particular object of the present invention to provide such a lens which has means to hold that lens in position on axis within the eye by means which do not cause irritation or other harm to the eye and which may be inserted into the eye through an opening of dimensions much smaller than that of the lens itself.

In accordance with one preferred embodiment of the invention, there is provided an intraocular lens which is formed of a central portion of optical grade materials (for example, PMMA) and a soft peripheral flange portion extending radially outward from the central optical portion and shaped into a soft, flexible and three-dimensionally curved shape such that it both softly and securely positions the lens for support within the eye. The structure permits the entire lens to be folded for insertion into the eye through the small opening of the iris and a still smaller opening in the anterior capsule of the natural lens. Once inserted, the lens unfolds and is positioned in proper location. The intraocular lens may be formed of one material, or it may be formed of a first material for the central optical portion and another softer material for the surrounding supporting structure. For example, the optical portion may be of PMMA and the flange material may be of a soft flexible material such as a silicone or a hydrogel. It is contemplated that the lens in accordance with the present invention will find its best application when positioned within the natural lens capsule of the eye after an opening is formed in the anterior capsule and the nucleus of the natural lens is completely removed.

The above brief outline and description of the invention will be best appreciated by reference to the following description, in conjunction with the drawings, wherein:

FIG. **1** is a partially schematic sectional view of a normal human eye;

FIG. **2** is a sectional view, similar to FIG. **1**, but with an intraocular lens in accordance with the present invention shown in position within the posterior capsule of the eye;

FIG. **3** is a partially schematic enlarged sectional view of a lens in accordance with the present invention within the posterior portion of the natural lens capsule;

FIG. **4** is a plan view of an intraocular lens in accordance with the present invention; and

FIGS. **5A**, B and C are sectional views of lenses in accordance with the present invention showing three alternative structures.

FIG. **1** shows a simplified view of the forward portion of the human eye **10** including the cornea **12**, the iris **14**, the natural lens **16**, the anterior capsule of the lens **18**, and the posterior capsule **20**. Surrounding the lens **16** is the ciliary body or ciliary muscles **22** which interconnect with the natural lens **16** by means of the zonule of Zinn which are schematically illustrated by the thin lings designated **24**. The vitreous body fills the cavity **26**. The retina lines the rearward portion of the cavity **26** and, of course, the optic nerve not visible in these drawings connects with the retina at the rear of that cavity.